SECTION 9.3

WILDFIRES

(Revised Methodology January 11, 1999)

EMISSION INVENTORY SOURCE CATEGORY
Natural (Non-Anthropogenic) Sources / Wildfires

EMISSION INVENTORY CODES (CES CODES) AND DESCRIPTION
930-930-0200-0000 (47308) Wildfires - Grass and Woodland

930-932-0200-0000 (47316) Wildfires - Timber and Brush

METHODS AND SOURCES

Emissions reported in these categories result from grass, woodland, timber and brush wildfires in 1996. EIC 930-930-0200-0000 covers grass, woodland, agricultural products and non-forest fires. EIC 930-932-0200-0000 covers brush and timber, including non-commercial timber and commercial timber fires.

Wildfire protection in California is provided by the California Department of Forestry (CDF) for state protected forests, the United States Forest Service (USFS) for federally protected forests, and local agencies. The CDF and USFS annual reports of the acreage burned in wildfires on the protected lands are used in this methodology. Typically, local agencies do not keep data on wildfires in their jurisdictions. Therefore, no local data was available to include in this methodology. However, based on the 1986 CDF map,[1] ARB staff determined that most of the locally protected land is in the Central Valley, the Southeast Desert, and metropolitan areas where wildfires are less prevalent. The omission of wildfire data from these areas would then be expected to have a minor impact on the total wildfire emission inventory.

The CDF report [2] divides the number of acres burned in each county into five categories: timber, woodland, grass, brush and agricultural products. For purposes of estimating emissions, agricultural products are assumed to be grasses. The acres burned reported by CDF were divided between air basins according to the portion of CDF-protected forest in each air basin, as determined by ARB staff using the CDF map. The percentages used to apportion CDF acreage to different air basins are shown below.

County	% Air Basin	% Air Basin	% Air Basin
El Dorado	LT - 0	MC - 100	
Kern	MOJ - 40	SJV - 60	
Los Angeles	SC - 60	MOJ - 40	
Placer	LT - 0	MC - 45	SV - 55
Riverside	SC - 85	SS - 15	MOJ - 0
Solano	SF - 45	SV - 55	
Sonoma	NC - 64	SF - 36	
San Bernardino	SC - 15	MOJ - 85	

The USFS report[3] provides the number of acres burned in each national forest. For 1996 all fires from the following national forests are assumed to be brush fires: Angeles, Cleveland, Mendocino, Los Padres, Sequoia and San Bernardino. All fires from the rest of the national forests in California are assumed to be timber fires.[4] The acreage burned in each national forest was allocated to the counties according to the percentage of the national forest area in each county/air basin determined by the National Forest Areas Report provided by the USFS.[5]

The CDF estimates fuel loading to be 2 tons/acre for grass and woodland and 15 tons/acre for timber and brush. These factors represent the amount of material expected to burn per acre, not necessarily the total vegetation per acre. Mature trees are not expected to be totally consumed in a fire, while small brush is, especially manzanita with its high oil content. In woodland areas, it is assumed that grass and fallen logs are the only materials burned. To determine emission factors in lbs/acre, emission factors in 1b/ton are converted using the fuel loading factors. AP-42 [6] emission factors in lb/ton are used to estimate grass and woodland emissions. Emission factors recommended by Hardy et al (1992) [7] and Nance et al (1993) [8] in lb/ton are used for timber and brush.

Wildfire Emission Factors

	Grass & Woodland 2 tons/acre		Timber & Brush 15 tons/acre	
	(lb/ton)	(lb/acre)	(lb/ton)	(lb/acre)
CO	101	202	166	2490
NOX	0	0	7.8	117
TOG	19.5	39	10	150
TSP	16	32	34	510

TEMPORAL INFORMATION

The annual activity is greatest from late spring to late fall. The weekly and daily activities are assumed to be nearly uniform.

ASSUMPTIONS

1. All acres burned in wildfires are reported by CDF or USFS, and there is no double counting.

2. Wildfires in areas under local jurisdictions are negligible and therefore not included in the emission estimates.

3. The fuel loading factors provided by CDF accurately represent the average loadings.

4. USFS data on acres burned can be divided into county/air basin based on percentage of national forest within each county/air basin determined from a 1986 CDF map and information from USFS. Likewise, CDF data can be divided into air basins based on percentage of CDF-protected forest determined from the same 1986 CDF map.

5. Wildfires occur predominately during relatively dry seasons, that is, from late spring to late fall.

CHANGES IN METHODOLOGY

Several emission factors have been revised for this methodology. The grass and woodland emission factor for TOG has been changed slightly to reflect the most recent AP-42 edition. All timber and brush emission factors have been changed to reflect more recent data.

The percentages used to apportion CDF acreage to different air basins have been revised, in part due to the formation of the Salton Sea Air Basin.

DIFFERENCES BETWEEN 1995 AND 1996 EMISSION ESTIMATES

The differences between the 1995 and 1996 estimates are due mainly to the difference in wildfire size and location. Wildfires in 1996 burned significantly more acreage than in recent years. Updated emission factors are lower for all pollutants except NOx.

GROWTH PARAMETERS

These categories are not grown.

RECOMMENDATIONS

The AP-42 section on wildfires will be updated in the near future. The new section should be reviewed for application to this methodology.

SAMPLE CALCULATIONS

To calculate the emissions from wildfires in San Luis Obispo County, begin with the number of acres reported by CDF as shown below:

1) Acres reported burned by CDF for San Luis Obispo County:

	Woodland	Grass	Agricultural	Timber	Brush
Acreage:	30	1,257	92	1	33,863

2) Then calculate the emissions from the Los Padres National Forest using the percentage of the forest within San Luis Obispo Co. and the number of acres burned in the Los Padres National Forest.

National Forest	% of Forest in San Luis Obispo Co.		Acres Burned in Forest		Acres Burned in San Luis Obispo Co.
Los Padres	11 %	x	111,153	=	12,226.83 acres

3) Add both San Luis Obispo Co. CDF acres and the Los Padres Nat. Forest acres.

For EIC 930-930-0200-0000 (CES 47308) Grass and Woodland, including Agriculture

Total Acres Burned 1,257 + 30 + 92 = 1,379 acres

For EIC 930-932-0200-0000 (CES 47316) Brush and Timber*

Total Acres Burned = 1 + 33,863 + 12,226.83 = 46,090.83 acres
(CDF + USFS) = total acres in San Luis Obispo)

* USFS has assumed that all USFS fires are either brush or timber fueled fires and should be counted under EIC 930-932-0200-0000 (CES 47316)

EMISSIONS = (Total Acres Burned) x (Emission Factor) / 2000 lb/ton

Wildfire Emissions for San Luis Obispo County (1996)

Wildfire Type	Acres Burned	Emission Factor (lb/Acre)				Emissions (tons/year)			
		CO	NOX	TOG	PM	CO	NOX	TOG	PM
Grass/Woodland	1,379	202	0	39	32	139.3	0	26.9	22.1
Timber/Brush	46,090.83	2490	117	150	510	57,383	2,696	3,457	11,753

Table - I

Fires Reported in National Forests in California
in 1996 - Apportioned by County

National Forest	Total Acres Burned in Forest	% of Forest in each Co**	Acres Burned in each Co
Angeles	28,400	100% in Los Angeles	28,400 .00
Cleveland	1,161	68% in San Diego	789.48
		13% in Orange	151.93
		19% in Riverside	220.59
El Dorado	119	73% in El Dorado	86.87
		12% in Amador	14.28
		8% in Alpine	9.52
		7% in Placer	8.33
Inyo	1,959	44% in Mono	861.96
		43% in Inyo	842.37
		10% in Tulare	195.90
		3% in Madera	58.77
Klamath	240	100% in Siskiyou	240.00
Lake Tahoe Basin	0	100% in El Dorado	0.0
Lassen	62	40% in Lassen	24.80
		23% in Shasta	14.26
		18% in Tehama	11.16
		14% in Plumas	8.68
		5% in Butte	3.10
Los Padres	111,153	36% in Santa Barbara	40,015.08
		30% in Ventura	33,345.90
		18% in Monterey	20,007.54
		11% in San Luis Obispo	12,226.83
		4% in Kern (SJV)	4,446.12
		1% in Los Angeles	1,111.53

** Data from the National Forest Areas Report

Table - I (Continued)

Fires Reported in National Forests in California
in 1996 - Apportioned by County

National Forest	Total Acres Burned in Forest	% of Forest In each County**	Acres Burned in ea. Co.
Mendocino	83,334	29% in Lake	24,166.86
		21% in Glenn	17,500.14
		20% in Mendocino	16,666.80
		14% in Tehama	11,666.76
		9% in Trinity	7,500.06
		7% in Colusa	5,833.38
Modoc	31,091	83% in Modoc	25,805.53
		9% in Lassen	2,798.19
		8% in Siskiyou	2.487.28
Plumas	6,452	75% in Plumas	4,839.00
		20% in Sierra	1,290.40
		5% in Butte	322.60
Rouge River	-0-	100% in Siskiyou	-0-
San Bernardino	15,463	70% in San Bernardino	10,824.10
		30% in Riverside	4,638.90
Sequoia	10,640	62% in Tulare	6,596.80
		26% in Kern	2,766.40
		12% in Fresno	1,276.80
Shasta-Trinity	4,251	53% in Trinity	2,253.03
		23% in Shasta	977.73
		21% in Siskiyou	892.71
		3% in Tehama	127.53
Sierra	8,423	66% in Fresno	5,559.18
		27% in Madera	2,274.21
		7% in Mariposa	589.61
Siskiyou	-0-	100% in Del Norte	-0-

** Data from the National Forest Areas Report

Table - I (Continued)

Fires Reported in National Forests in California
Apportioned by County

National Forest	Total Acres Burned in Forest	% of Forest In each County**	Acres Burned in ea. Co.
Six Rivers	775	42% in Del Norte	325.50
		34% in Humboldt	263.50
		23% in Trinity	178.25
		1% in Siskiyou	7.75
Stanislaus	31,804	68% in Tuolumne	21,626.72
		13% in Alpine	4,134.52
		9% in Mariposa	2,862.36
		9% in Calaveras	2,862.36
Tahoe	425	43% in Placer	182.75
		33% in Sierra	140.25
		20% in Nevada	85.00
		2% in Sierra	8.50
		1% in El Dorado	4.25

** Data from the National Forest Areas Report

REFERENCES

1. California Department of Forestry, Map: California Department of Forestry Facilities, North Half and South Half, (1986).

2. California Department of Forestry and Fire Protection, 1996 Emergency Activity Report, Protection Responsibility Acres Damaged by Vegetation Fire Type by County.

3. U.S. Department of Agriculture, Forest Service, National Forest Fires Annual Fire Report 1998.

4. Biehl, Gary, USFS, CA Personal Communication.

5. U.S. Department of Agriculture, Forest Service, National Forest Areas Report, as of September 30, 1987. Net Area of National Forest and Other Lands Administered by the Forest Service Listed by State, Congressional Districts and Counties.

6. U.S. Environmental Protection Agency, Compilation of Air Pollution Emission Factors, AP-42, Table 2.5-5 (October 1992).

7. Hardy, C.C., D.E. Ward, W. Einfield, 1992, PM2.5 Emissions From a Major Wildfire Using a GIS: Rectification of airborne Measurements, proceedings of the 29th Annual Meeting of the Pacific Northwest International Section, Air and Waste Management Association.

8. Nance, J.D., P.V., Hobbs, L.F. Radke, and D.E. Ward, 1993, Airborne Measurements of Gases and Particles from an Alaskan Wildfire, Journal of Geophysical Research, 98(D8): 14,873-14,881.

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Table II
1996 Area Source Emissions
Activity: Unspecified Activities
Process: Wild Fires
Entrainment: Solid Material Combustion
Dimn: Grass & Woodland
CES: 47308
Process Rate Unit: Acres

AB	County	Process Rate	TOG Emis. (Tons / Year)	CO Emis. (Tons / Year)	NOX Emis. (Tons / Year)	SOX Emis. (Tons / Year)	PM Emis. (Tons / Year)
GBV	ALPINE	0	0.00	0.00	0.00	0.00	0.00
	INYO	5	0.10	0.51	0.00	0.00	0.08
	MONO	0	0.00	0.00	0.00	0.00	0.00
LC	LAKE	669	13.05	67.57	0.00	0.00	10.70
LT	EL DORADO	0	0.00	0.00	0.00	0.00	0.00
	PLACER	0	0.00	0.00	0.00	0.00	0.00
MC	AMADOR	251	4.89	25.35	0.00	0.00	4.02
	CALAVERAS	1613	31.45	162.91	0.00	0.00	25.81
	EL DORADO	10174	198.39	1027.57	0.00	0.00	162.78
	MARIPOSA	2507	48.89	253.21	0.00	0.00	40.11
	NEVADA	258	5.03	26.06	0.00	0.00	4.13
	PLACER	159	3.10	16.04	0.00	0.00	2.54
	PLUMAS	0	0.00	0.00	0.00	0.00	0.00
	SIERRA	0	0.00	0.00	0.00	0.00	0.00
	TUOLUMNE	8353	162.88	843.65	0.00	0.00	133.65
MOJ	IMPERIAL	0	0.00	0.00	0.00	0.00	0.00
	KERN	0	0.00	0.00	0.00	0.00	0.00
	LOS ANGELES	0	0.00	0.00	0.00	0.00	0.00
	RIVERSIDE	0	0.00	0.00	0.00	0.00	0.00
	SAN BERNARDINO	383	7.48	38.72	0.00	0.00	6.13
NC	DEL NORTE	9	0.18	0.91	0.00	0.00	0.14
	HUMBOLDT	327	6.38	33.03	0.00	0.00	5.23
	MENDOCINO	337	6.57	34.04	0.00	0.00	5.39
	SONOMA	598	11.67	60.44	0.00	0.00	9.57
	TRINITY	5	0.10	0.51	0.00	0.00	0.08
NCC	MONTEREY	3864	75.35	390.26	0.00	0.00	61.82
	SAN BENITO	334	6.51	33.73	0.00	0.00	5.34
	SANTA CRUZ	29	0.57	2.93	0.00	0.00	0.46
NEP	LASSEN	1027	20.03	103.73	0.00	0.00	16.43
	MODOC	97	1.89	9.80	0.00	0.00	1.55
	SISKIYOU	657	12.81	66.36	0.00	0.00	10.51
SC	LOS ANGELES	0	0.00	0.00	0.00	0.00	0.00
	ORANGE	0	0.00	0.00	0.00	0.00	0.00
	RIVERSIDE	9929	193.61	1002.81	0.00	0.00	158.86
	SAN BERNARDINO	67.65	1.32	6.83	0.00	0.00	1.08
SCC	SAN LUIS OBISPO	1379	26.89	139.28	0.00	0.00	22.06
	SANTA BARBARA	0	0.00	0.00	0.00	0.00	0.00
	VENTURA	0	0.00	0.00	0.00	0.00	0.00
SD	SAN DIEGO	1279	24.94	129.18	0.00	0.00	20.46
SF	ALAMEDA	2071	40.38	209.17	0.00	0.00	33.14
	CONTRA COSTA	537	10.47	54.24	0.00	0.00	8.59
	MARIN	0	0.00	0.00	0.00	0.00	0.00
	NAPA	112	2.18	11.31	0.00	0.00	1.79
	SAN FRANCISCO	0	0.00	0.00	0.00	0.00	0.00
	SAN MATEO	258	5.03	26.06	0.00	0.00	4.13
	SANTA CLARA	710	13.85	71.71	0.00	0.00	11.36
	SOLANO	525	10.23	52.99	0.00	0.00	8.40
	SONOMA	337	6.56	34.00	0.00	0.00	5.39
SJV	FRESNO	35334	689.01	3568.73	0.00	0.00	565.34
	KERN	0	0.00	0.00	0.00	0.00	0.00
	KINGS	0	0.00	0.00	0.00	0.00	0.00
	MADERA	3316	64.66	334.92	0.00	0.00	53.06
	MERCED	23653	461.23	2388.95	0.00	0.00	378.45
	SAN JOAQUIN	345	6.73	34.85	0.00	0.00	5.52
	STANISLAUS	734	14.31	74.13	0.00	0.00	11.74
	TULARE	2670	52.07	269.67	0.00	0.00	42.72
SS	IMPERIAL	0	0.00	0.00	0.00	0.00	0.00
	RIVERSIDE	1752	34.17	176.97	0.00	0.00	28.03
SV	BUTTE	1737	33.87	175.44	0.00	0.00	27.79
	COLUSA	345	6.73	34.85	0.00	0.00	5.52
	GLENN	111	2.16	11.21	0.00	0.00	1.78
	PLACER	194	3.79	19.61	0.00	0.00	3.11
	SACRAMENTO	90	1.76	9.09	0.00	0.00	1.44
	SHASTA	977	19.05	98.68	0.00	0.00	15.63
	SOLANO	641	12.51	64.77	0.00	0.00	10.26
	SUTTER	0	0.00	0.00	0.00	0.00	0.00
	TEHAMA	1319	25.72	133.22	0.00	0.00	21.10
	YOLO	115	2.24	11.62	0.00	0.00	1.84
	YUBA	93	1.81	9.39	0.00	0.00	1.49
TOTAL		122286.65	2384.60	12351.01	0.00	0.00	1956.55

Fraction of Reactive Organic Gases (FROG): 0.7218 (Reactive Organic Gases (ROG) Emissions = TOG X FROG)
Fraction of PM10 (FRPM10): 0.9825 (PM10 Emissions = PM X FRPM10)

Table III
1996 Area Source Emissions
Activity: Unspecified Activities
Process: Wild Fires
Entrainment: Solid Material Combustion
Dimn: Timber & Brush
CES: 47316
Process Rate Unit: Acres

AB	County	Process Rate	TOG Emis. (Tons / Year)	CO Emis. (Tons / Year)	NOX Emis. (Tons / Year)	SOX Emis. (Tons / Year)	PM Emis. (Tons / Year)
GBV	ALPINE	4144	310.80	5159.33	242.43	0.00	1056.73
	INYO	846	63.48	1053.73	49.51	0.00	215.82
	MONO	862	64.65	1073.14	50.42	0.00	219.80
LC	LAKE	24518	1838.84	30524.74	1434.29	0.00	6252.05
LT	EL DORADO	4	0.32	5.29	0.25	0.00	1.08
	PLACER	191	14.33	237.89	11.18	0.00	48.73
MC	AMADOR	21	1.60	26.49	1.24	0.00	5.43
	CALAVERAS	7656	574.23	9532.17	447.90	0.00	1952.37
	EL DORADO	163	12.22	202.77	9.53	0.00	41.53
	MARIPOSA	5461	409.57	6798.91	319.47	0.00	1392.55
	NEVADA	95	7.13	118.28	5.56	0.00	24.23
	PLACER	17	1.30	21.58	1.01	0.00	4.42
	PLUMAS	4849	363.65	6036.61	283.65	0.00	1236.41
	SIERRA	1439	107.94	1791.74	84.19	0.00	366.98
	TUOLUMNE	26031	1952.30	32408.25	1522.80	0.00	6637.83
MOJ	IMPERIAL	0	0.00	0.00	0.00	0.00	0.00
	KERN	4446	333.46	5535.42	260.10	0.00	1133.76
	LOS ANGELES	0	0.00	0.00	0.00	0.00	0.00
	RIVERSIDE	4639	347.92	5775.43	271.38	0.00	1182.92
	SAN BERNARDINO	12437	932.81	15484.56	727.59	0.00	3171.54
NC	DEL NORTE	333	24.94	413.96	19.45	0.00	84.79
	HUMBOLDT	331	24.79	411.47	19.33	0.00	84.28
	MENDOCINO	16799	1259.91	20914.51	982.73	0.00	4283.69
	SONOMA	1062	79.68	1322.69	62.15	0.00	270.91
	TRINITY	9933	745.00	12367.01	581.10	0.00	2533.00
NCC	MONTEREY	20556	1541.67	25591.65	1202.50	0.00	5241.66
	SAN BENITO	54	4.05	67.23	3.16	0.00	13.77
	SANTA CRUZ	46	3.45	57.27	2.69	0.00	11.73
NEP	LASSEN	4504	337.80	5607.47	263.48	0.00	1148.52
	MODOC	25823	1936.69	32149.05	1510.62	0.00	6584.75
	SISKIYOU	3717	278.76	4627.34	217.43	0.00	947.77
SC	LOS ANGELES	29512	2213.36	36741.85	1726.42	0.00	7525.44
	ORANGE	151	11.32	187.91	8.83	0.00	38.49
	RIVERSIDE	221	16.54	274.63	12.90	0.00	56.25
	SAN BERNARDINO	285	21.35	354.45	16.65	0.00	72.60
SCC	SAN LUIS OBISPO	46091	3456.81	57383.08	2696.31	0.00	11753.16
	SANTA BARBARA	40015	3001.13	49818.77	2340.88	0.00	10203.85
	VENTURA	33346	2500.94	41515.65	1950.74	0.00	8503.20
SD	SAN DIEGO	33550	2516.29	41770.35	1962.70	0.00	8555.37
SF	ALAMEDA	151	11.33	188.00	8.83	0.00	38.51
	CONTRA COSTA	21	1.58	26.15	1.23	0.00	5.36
	MARIN	0	0.00	0.00	0.00	0.00	0.00
	NAPA	19	1.43	23.66	1.11	0.00	4.85
	SAN FRANCISCO	0	0.00	0.00	0.00	0.00	0.00
	SAN MATEO	16	1.20	19.92	0.94	0.00	4.08
	SANTA CLARA	95	7.13	118.28	5.56	0.00	24.23
	SOLONO	225	16.88	280.13	13.16	0.00	57.38
	SONOMA	598	44.82	744.01	34.96	0.00	152.39
SJV	FRESNO	8972	672.90	11170.12	524.86	0.00	2287.85
	KERN	2766.4	207.48	3444.17	161.83	0.00	705.43
	KINGS	0	0.00	0.00	0.00	0.00	0.00
	MADERA	2337	175.27	2909.54	136.71	0.00	595.93
	MERCED	2	0.15	2.49	0.12	0.00	0.51
	SAN JOAQUIN	0	0.00	0.00	0.00	0.00	0.00
	STANISLAUS	2	0.15	2.49	0.12	0.00	0.51
	TULARE	8522	639.13	10609.52	498.52	0.00	2173.03
SS	IMPERIAL	0	0.00	0.00	0.00	0.00	0.00
	RIVERSIDE	3095	232.14	3853.59	181.07	0.00	789.29
SV	BUTTE	350	26.23	435.38	20.46	0.00	89.17
	COLUSA	6011	450.85	7484.17	351.67	0.00	1532.90
	GLENN	17515	1313.64	21806.35	1024.64	0.00	4466.36
	PLACER	11	0.83	13.70	0.64	0.00	2.81
	SACRAMENTO	0	0.00	0.00	0.00	0.00	0.00
	SHASTA	1288	96.6.	1603.55	75.35	0.00	328.44
	SOLANO	275	20.63	342.38	16.09	0.00	70.13
	SUTTER	0	0.00	0.00	0.00	0.00	0.00
	TEHAMA	11811	885.86	14705.26	690.97	0.00	3011.92
	YOLO	1	0.08	1.25	0.06	0.00	0.26
	YUBA	5	0.38	6.23	0.29	0.00	1.28
TOTAL		428236.4	32117.72	533153.01	25051.76	0.00	109200.03

Fraction of Reactive Organic Gases (FROG): 0.7218 (Reactive Organic Gases (ROG) Emissions = TOG X FROG)
Fraction of PM10 (FRPM10): 0.9610 (PM10 Emissions = PM X FRPM10)